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Advisory Circular

Subject: Change 10 to STANDARDS FOR SPECIFYING
CONSTRUCTION OF AIRPORTS

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Initiated by: AM-200 **Change:** 10

1. PURPOSE. GENERAL PROVISIONS SECTION 110 METHOD OF ESTIMATING PERCENTAGE OF MATERIAL **WITHIN SPECIFICATION LIMITS (PWL)**, ITEM P-401 PLANT MIX BITUMINOUS PAVEMENTS, and ITEM P-501 PORTLAND CEMENT CONCRETE PAVEMENT have been revised to clarify **PWL** concepts, incorporate new acceptance criteria, test procedures, and pay adjustment schedules.

2. PRINCIPAL CHANGES. The following principal changes have been made:

a. Paragraph 1 **10-01 GENERAL** has been revised to **clarify** **PWL** concepts and to incorporate revisions that specifically address the degree of uncertainty (risk) associated with acceptance plans when small tractions of material are used to evaluate a day's production. The paragraph informs the Contractor that production quality levels must be maintained at the acceptable **PWL** or higher in order to consistently meet acceptance criteria.

b. Paragraph 40 **1-5.1a(1) SAMPLING** has been changed to specify that specimens shall be placed in an oven for 30-60 minutes to stabilize the specimen to the compaction temperature.

c. Paragraph **401-5.1a(2) TESTING** has been changed to specify a measurement of the maximum specific gravity for each **sublot** and to add container size E in ASTM D 2041 test method.

d. Paragraph **401-5.1b(4) TESTING** has been changed to specify the procedure for laboratory prepared thoroughly dry specimens in ASTM D 2726 for plant-produced material.

e. Paragraph **401-5.1c PARTIAL LOTS - PLANT-PRODUCED MATERIAL** has been changed to allow the Engineer and Contractor to **modify** lot size when small amounts of work are anticipated.

f. Paragraphs **401-5.2b STABILITY, FLOW, and AIR VOIDS**, **401-5.1c MAT DENSITY**, and **401-5.2d JOINT DENSITY** have been revised to indicate the Contractor shall target production quality to achieve 90 **PWL** or higher.

g. Paragraphs **401-5.2g OUTLIERS** has been added to check for outliers at a significance level of five percent.

h. Paragraphs **401.8.1 PAYMENT** and **401-8.1a BASIS OF ADJUSTED PAYMENT**, and Table 6 **PRICE ADJUSTMENT SCHEDULE** have been changed to incorporate new acceptance criteria and pay adjustment schedule based on a new **PWL** range from 55-90 percent. Payment has been revised to allow up to 106 percent payment on a lot basis and a range from 1 **00-** 106 percent on a project basis, based on total project payment conditions.

i. Paragraph 501-3.1 **PROPORTIONS** has been changed to be consistent with new acceptance criteria regarding specified strength and the need to overdesign to meet specification requirements.

j. Paragraph **501-5.1a(2) TESTING** has been changed to require two specimens per **sublot**.

k. Paragraph 501-5.1c **PARTIAL LOTS** has been changed to allow the Engineer and Contractor to modify lot size when small amounts of work are anticipated.

l. Paragraph **501-5.1d OUTLIERS** has been added to check for outliers at a significance level of five percent.

m. Paragraphs **501-5.2b FLEXURAL STRENGTH** and **501-5.2c PAVEMENT THICKNESS** have been changed to indicate that the Contractor shall target production quality to achieve 90 PWL or higher.

n. Paragraph **501-5.2d PERCENTAGE OF MATERIAL WITHIN SPECIFICATION LIMITS (PWL)** has been changed to incorporate new lower specification limits for strength (0.93 x design) and thickness (plan - 0.50 inches) based on new acceptance criteria and new pay adjustment schedule.

o. Paragraphs **501-5.2e(1) FLEXURAL STRENGTH** and **501-5.2e(2) THICKNESS** have been changed to incorporate new acceptance PWL of 90 percent or higher.

p. Paragraphs 501-8.1 GENERAL and all subparagraphs have been deleted.

q. Paragraphs 501-8.1 PAYMENT and **501-8.1a BASIS OF ADJUSTED PAYMENT**, and Table 3 PRICE ADJUSTMENT SCHEDULE have been added to incorporate new acceptance criteria and pay adjustment schedule based on a new PWL range **from** 55-90 percent applicable to both strength and thickness. Payment has been revised to allow up to 106 percent payment on a lot basis and a range from **100-106** percent on a project, based on total project payment conditions.

The change number and date are shown at the top of each page.

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SECTION 110

METHOD OF ESTIMATING PERCENTAGE OF MATERIAL WITHIN SPECIFICATION LIMITS (PWL)

110-01 GENERAL. When the specifications provide for acceptance of material based on the method of estimating percentage of material within specification limits (**PWL**), the PWL will be determined in accordance with this section. All test results for a lot will be analyzed statistically to determine the total estimated percent of the lot that is within specification limits. The PWL is computed using the sample average (**X**) and sample standard deviation (S.) of the specified number (n) of **sublots** for the lot and the specification tolerance limits, L for lower and U for upper, for the particular acceptance parameter. From these values, the respective Quality index(s), **Q_L** for Lower Quality Index and/or **Q_U** for Upper Quality Index, is computed and the PWL for the lot for the specified n is determined **from Table 1.**

There is some degree of uncertainty (risk) in the measurement for acceptance because only a small fraction of production material (the population) is sampled and tested. This uncertainty exists because all portions of the production material have the same probability to be randomly sampled. The Contractor's risk is the probability that material produced at the acceptable quality level is rejected or subjected to a pay adjustment. The Owner's risk is the probability that material produced at the rejectable quality level is accepted.

IT IS THE INTENT OF THIS SECTION TO INFORM THE CONTRACTOR THAT, IN ORDER TO CONSISTENTLY OFFSET THE CONTRACTOR'S RISK FOR MATERIAL EVALUATED, PRODUCTION QUALITY (USING POPULATION AVERAGE AND POPULATION STANDARD DEVIATION) MUST BE MAINTAINED AT THE ACCEPTABLE QUALITY SPECIFIED OR HIGHER IN ALL CASES, IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PRODUCE AT QUALITY LEVELS THAT WILL MEET THE SPECIFIED ACCEPTANCE CRITERIA WHEN SAMPLED AND TESTED AT THE FREQUENCIES SPECIFIED.

Paragraph 110-01 shall be included verbatim in all projects.

110-02 METHOD FOR COMPUTING PWL. The computational sequence for computing PWL is as follows:

- Divide the lot into n **sublots** in accordance with the acceptance requirements of the specification.
- Locate the random sampling position within the **sublot** in accordance with the requirements of the specification.
- Make a measurement at each location, or take a test portion and make the measurement on the test portion in accordance with the testing requirements of the specification.
- Find the sample average (\bar{X}) for all **sublot** values within the lot by using the following formula:

$$X = (x_1 + x_2 + x_3 + \dots + x_n)/n$$

Where:

X	=	Sample average of all subplot values within a lot
x_1, x_2	=	Individual subplot values
n	=	Number of subplots

- e. Find the sample standard deviation (**S_n**) by use of the following formula:

$$S_n = [(d_1^2 + d_2^2 + d_3^2 + \dots d_n^2)/(n-1)]^{1/2}$$

Where: S_n = Sample standard deviation of the number of **subplot** values in the set
 d_1, d_2, \dots = Deviations of the individual **subplot** values x_1, x_2, \dots from the average value \bar{X}
that is: $d_1 = (x_1 - \bar{X})$, $d_2 = (x_2 - \bar{X}) \dots d_n = (x_n - \bar{X})$
 n = Number of **subplots**

- f. For single sided specification limits (i.e., L only), compute the Lower Quality Index Q_L by use of the following formula:

$$Q_L = (X - L) / S_n$$

Where: L = specification lower tolerance limit

401-4.9 PREPARATION OF THE UNDERLYING SURFACE. Immediately before placing the bituminous mixture, the underlying course shall be cleaned of all dust and debris. A prime coat or tack coat shall be applied in accordance with Item P-602 or P-603, if required by the contract specifications.

401-4.10 TRANSPORTING, PLACING, AND FINISHING. The bituminous mixture shall be transported from the mixing plant to the site in vehicles conforming to the requirements of paragraph 401-3. Deliveries shall be scheduled so that placing and compacting of mixture is uniform with **minimum** stopping and starting of the paver. Adequate artificial lighting shall be provided night placements. Hauling over **freshly** placed material shall not be permitted **until** the material has been compacted, as specified, and allowed to cool to atmospheric temperature.

[The Contractor may elect to use a material transfer vehicle to deliver mix to the paver.]

Use of a material transfer vehicle allows the paver to be operated almost continuously without stopping between truckloads of mix, if a continuous supply of mix is available from the asphalt plant.

The mix shall be placed and compacted at a temperature suitable for obtaining density, surface smoothness, and other specified requirements but not less than 250 degrees F (107 degrees C).

Upon arrival, the mixture shall be placed to the full width by a bituminous paver. It shall be struck off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and conform to the grade and contour indicated. The speed of the paver shall be regulated to eliminate pulling and tearing of the bituminous mat. Unless otherwise permitted, placement of the mixture shall begin along the centerline of a crowned section or on the high side of areas with a one-way slope. The mixture shall be placed in consecutive adjacent strips having a minimum width of [] except where edge lanes require less width to complete the area. The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least 1 foot (30 cm); however, the joint in the surface top course shall be at the centerline of the pavement. Transverse joints in one course shall be offset by at least 10 feet (3 m) from transverse joints in the previous course.

Transverse joints in adjacent lanes shall be offset a minimum of 10 feet (3 m).

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread and luted by hand tools.

The Engineer should specify the widest paving lane practicable in an effort to hold the number of longitudinal joints to a minimum.

401-4.11 COMPACTION OF MIXTURE. After placing, the mixture shall be thoroughly and uniformly compacted by rolling. The surface shall be compacted as soon as possible when the mixture has attained sufficient stability so that the rolling does not cause undue displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor. The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained.

To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened (and scrapers used), but excessive water will not be permitted.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with hand tampers.

Any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or in any way defective shall be removed and replaced with **fresh** hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching shall not be allowed.

The stability and flow for each **sublot** shall be computed by averaging the results of all test specimens representing that **sublot**.

(3) **Acceptance.** Acceptance of plant produced material for stability, flow, and air voids shall be determined by the Engineer in accordance with the requirements of paragraph **401-5.2b**.

b. **Field Placed Material.** Material placed in the field shall be tested for mat and joint density on a lot basis.

(1) **Mat Density.** The lot size shall be the same as that indicated in paragraph 401-5.1 .a and shall be divided into four equal **sublots**. One core of finished, compacted materials shall be taken by the Contractor **from** each **sublot**. Core locations will be determined by the Engineer on a random basis in accordance with procedures contained in ASTM D 3665. Cores shall not be taken closer than one foot **from** a transverse or longitudinal joint.

(2) **Joint Density.** The lot size shall be the total length of longitudinal joints constructed by a lot of material as defined in paragraph **401-5.1a**. The lot shall be divided into four equal **sublots**. One core of finished, compacted materials shall be taken by the Contractor **from** each **sublot**. Core locations will be determined by the Engineer on a random basis in accordance with procedures contained in ASTM D 3665.

(3) **Sampling.** Samples shall be neatly cut with a core drill. The cutting edge of the core drill bit shall be of hardened steel or other suitable material with diamond chips embedded in the metal cutting edge. The minimum diameter of the sample shall be three inches. Samples that are clearly defective, as a result of sampling, shall be discarded and another sample taken. The Contractor shall **furnish** all tools, labor, and materials for cutting samples and filling the cored pavement. Cored holes **shall** be filled in a manner acceptable to the Engineer and within one day after sampling.

(4) **Testing.** The bulk specific gravity of each cored sample will be measured by the Engineer in accordance with ASTM D 2726 or ASTM D 1188, whichever is applicable. The percent compaction (density) of each sample will be determined by dividing the bulk specific gravity of each **sublot** sample by the average bulk specific gravity of all laboratory prepared specimens for the lot, as determined in paragraph 401-5.1 a(2).

(5) **Acceptance.** Acceptance of field placed material for mat density will be determined by the Engineer in accordance with the requirements of paragraph **401-5.2c**. Acceptance for joint density will be determined in accordance with the requirements of paragraph **401-5.2d**.

c. **Partial Lots - Plant-Produced Material.** When operational conditions cause a lot to be terminated before the specified number of tests have been made for the lot, or when the Contractor and Engineer agree in writing to allow overages or other minor tonnage placements to be considered as partial lots, the following procedure will be used to adjust the lot size and the number of tests for the lot.

The last batch produced where production is halted will be sampled, and its properties shall be considered as representative of the particular **sublot** **from** which it was taken. Where three **sublots** are produced, they shall constitute a lot. Where one or two **sublots** are produced, they shall be incorporated into the next lot, and the total number of **sublots** shall be used in the acceptance plan Calculation, i.e., $n = 5$ or $n = 6$, for example.

d. **Partial Lots - Field Placed Material.** The lot size for field placed material shall correspond to that of the plant material, except that, in no cases, less than (3) cored samples **shall** be obtained for the acceptance plan calculations, i.e., $n = 3$.

(5) **Smoothness.** The finished surfaces of the pavement shall not vary more than [] for the [surface] [base] course. Each lot shall be evaluated with a 12-foot (3.6 m) straightedge. The lot size shall be [] square yards (square meters). Measurements will be made perpendicular and parallel to the centerline at distances not to exceed 50 feet (15.2 m). When more than 15 percent of all measurements within a lot exceed the specified tolerance, the Contractor shall remove the deficient area and replace with new material. Sufficient material shall be removed to allow at least one inch of asphalt concrete to be placed. Skin patching shall not be permitted. High points may be ground off.

Specify 3/8 inch (9.5 mm) for base course and 1/4 inch (6.2 mm) for surface course.

The Engineer shah specify the lot size. A minimum of 2,000 square yards (1 650 square meters) is recommended.

(6) **Grade.** The finished surface of the pavement shall not vary from the gradeline elevations and cross sections shown on the plans by more than 1/2 inch (12.70 mm). The finished grade of each lot will be determined by running levels at intervals of 50 feet (15.2 m) or less longitudinally and transversely to determine the elevation of the completed pavement. The lot size shall be [] square yards (square meters). When more than 15 percent of all the measurements within a lot are outside the specified tolerance, the Contractor shall remove the deficient area and replace with new material. Sufficient material shall be removed to allow at least one inch of asphalt concrete to be placed. Skin patching for correcting low areas shall not be permitted. High points may be ground off.

A minimum lot size of 2,000 square yards (1650 square meters) is recommended.

g. **Outliers.** All individual tests for mat density and air voids shall be checked for outliers (test criterion) in accordance with ASTM E 178, at a significance level of 5 percent. Outliers shall be discarded, and the PWL shall be determined using the remaining test values.

TABLE 5. ACCEPTANCE LIMITS FOR STABILITY, FLOW, AIR VOIDS, AND DENSITY

	Pavements Designed for Aircraft Gross Weights of 60,000 Lbs. or More or Tire Pressure of 100 Psi or More		Pavements Designed for Aircraft Cross Weight Less Than 60,000 Lbs. or Tire Pressure Less Than 100 Psi	
Test Property				
Number Blows	75		50	
	Specification Tolerance Limit		Specification Tolerance Limit	
	L	U	L	U
Stability, minimum, pounds	1800	-	1000	-
Flow, 0.01-inch	8	16	8	20
Air Voids Total Mix, percent	2	5	2	5
Mat Density, percent	96.3	-	96.3	-
Joint Density, percent	93.3	-	93.3	-

A lot is the quantity of material to be controlled and may represent a specified tonnage or a specified number of truckloads. The lot size, to be determined by the Engineer, should, for the most part, depend on the operational capacity of the plant, but shah in no case exceed 2,000 tons (1 814 000 kg) in accordance with paragraph 401-5a.l.

the 1/t-inch (12.5 mm) gradation, the 1/2-inch sieve should be deleted from the Range Chart.

METHOD OF MEASUREMENT

401-7.1 MEASUREMENT. Plant mix bituminous concrete pavement shall be measured by the number of tons (kg) of bituminous mixture [and the number of tons (kg) of bituminous material] used in the accepted work. Recorded batch weights or truck scale weights will be used to determine the basis for the tonnage. [The weight of bituminous material shall be adjusted in accordance with the percentage of bitumen as determined in paragraph 401-6.3a.]

BASIS OF PAYMENT

401-8.1 PAYMENT. Payment for an accepted lot of bituminous concrete pavement shall be made at the contract unit price per ton (kg) for bituminous mixture [and bituminous material] adjusted according to paragraph 401-8.1a, subject to the limitation that:

The total project payment for plant mix bituminous concrete pavement shall not exceed [] percent of the product of the contract unit price and the total number of tons (kg) of bituminous mixture [and [] percent of the product of the contract unit price and the number of tons (kg) of bituminous material] used in the accepted work (See Note 2 under Table 6).

The price shall be compensation for furnishing all materials, for all preparation, mixing, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

The Engineer shall specify a value ranging from 100 to 106 percent. When the total project payment for Item P-401 pavement exceeds the contract unit price, any AIP or PFC funds used to pay the excess may require an amendment to the AIP grant or PFC application for the project.

a. Basis of Adjusted Payment. The pay factor for each individual lot shall be calculated in accordance with Table 6. A pay factor shall be calculated for both mat density and air voids. The lot pay factor shall be the higher of the two values when calculations for both mat density and air voids are 100 percent or higher. The lot pay factor shall be the product of the two values when only one of the calculations for either mat density or air voids is 100 percent or higher. The lot pay factor shall be the lower of the two values when calculations for both mat density and air voids are less than 100 percent. [The lot pay factor shall apply to both the bituminous mixture and the bituminous material.]

TABLE 6. PRICE ADJUSTMENT SCHEDULE¹

Percentage of Material Within Specification Limits (PWL)	Lot Pay Factor (Percent of Contract Unit Price)
96 - 100	106
90-95	PWL + 10
75-89	0.5PWL + 55
55 - 74	1.4PWL - 12
Below 55	Reject ²

¹ ALTHOUGH IT IS THEORETICALLY POSSIBLE TO ACHIEVE A PAY FACTOR OF 106 PERCENT FOR EACH LOT, ACTUAL PAYMENT ABOVE 100 PERCENT SHALL BE SUBJECT TO THE TOTAL PROJECT PAYMENT LIMITATION SPECIFIED IN PARAGRAPH 401-8.1.

² The lot shall be removed and replaced. However, the Engineer may decide to allow the rejected lot to remain. In that case, if the Engineer and Contractor agree in writing that the lot shall not be removed, it shall be paid for at 50 percent of the contract unit price AND THE TOTAL PROJECT PAYMENT LIMITATION SHALL BE REDUCED BY THE AMOUNT WITHHELD FOR THE REJECTED LOT.

ASTM D 3666	Inspection and Testing Agencies for Bituminous Paving Materials
ASTM D 4 125	Asphalt Content of Bituminous Mixtures by the Nuclear Method
ASTMD4318	Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 479 1	Flat or Elongated Particles in Coarse Aggregate
ASTM D 4867	Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM E 178	Practice for Dealing With Outlying Observations
AASHTO T 30	Mechanical Analysis of Extracted Aggregate
The Asphalt Institute's Manual No. 2 (MS-2)	Mix Design Methods for Asphalt Concrete
The Asphalt Institute's Manual No. 20 (MS-20)	Hot-Mix Recycling

MATERIAL REQUIREMENTS

ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 946	Asphalt Cement for Use in Pavement Construction
ASTM D 3381	Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 4552	Classifying Hot-Mix Recycling Agents

The Engineer shall designate one of the following:

Welded steel wire fabric	ASTM A 185
Welded deformed steel fabric	ASTM A 497
Bar mats	ASTM A 184 or A 704

Welded wire fabric shall be **furnished** in flat sheets only.

Delete this paragraph when not applicable to the project.

501-2.7 DOWEL AND TIE BARS. Tie bars shall be deformed steel bars and conform to the requirements of ASTM A 615, ASTM A 616, or ASTM A 617, except that rail steel bars, Grade 50 or 60, shall not be used for tie bars that are to be bent or restraightened during construction. Tie bars designated as Grade 40 in ASTM A 615 can be used for construction requiring bent bars.

Dowel bars shall be plain steel bars conforming to ASTM A 615, ASTM A 616 or ASTM A 617 and shall be **free from** burring or other deformation restricting slippage in the concrete. High strength dowel bars shall conform to ASTM A 714, Class 2, Type S, Grade I, II or III, Bare Finish. Before delivery to the construction site each dowel bar shall be painted on all **surfaces** with one coat of paint meeting Federal Specification TT-P-664. If plastic or epoxy-coated steel dowels are used no paint coating is required, except when specified for a particular situation on the plans. Coated dowels shall conform to the requirements of **AASHTO M 254**.

The sleeves for dowel bars used in expansion joints shall be metal or other type of an approved design to cover 2 to 3 inches (50 mm to 75 mm) of the dowel, with a closed end and with a suitable stop to hold the end of the bar at least 1 inch (25 mm) **from the** closed end of the sleeve. Sleeves shall be of such design that they will not collapse during construction.

501-2.8 WATER Water used in mixing or curing shall be clean and **free** of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product. Water will be tested in accordance with the requirements of **AASHTO T 26**. Water known to be of potable quality may be used without testing.

501-2.9 COVER MATERIAL, FOR CURING. Curing materials shall conform to one of the following specifications:

- a. Liquid membrane-forming compounds for curing concrete shall conform to the requirements of ASTM C 309, Type 2, Class B
- b. White polyethylene **film** for curing concrete shall conform to the requirements of ASTM C 17 1.
- c. White burlap-polyethylene sheeting for curing concrete shall conform to the requirements of ASTM C 171.
- d. Waterproof paper for curing concrete shall conform to the requirements of ASTM C 17 1.

5 0 1 - 2 . 1 0 A D - . The use of any material added to the concrete mix shall be approved by the Engineer. The Contractor shall submit certificates indicating that the material to be furnished meets all of the requirements indicated below. In addition, the Engineer may require the Contractor to submit complete test data from an approved laboratory showing that the material to be furnished meets all of the requirements of the cited specifications. Subsequent tests may be made of samples taken by the Engineer from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved

a. Air-Entrain& Admixtures. Air-entraining admixtures shall meet the requirements of ASTM C 260 and shall consistently entrain the air content in the specified ranges under field conditions. The **air-entrainment** agent and any water reducer admixture shall be compatible.

b. Chemical Admixtures. Water-reducing, set retarding, and set-accelerating admixtures shall meet the requirements of ASTM C 494, including the **flexural** strength test.

501-2.11 EPOXY-RESIN. Epoxy-resin used to anchor dowels and tie bars in pavements shall conform to the requirements of ASTM C 881, Type I, Grade 3, Class C. Class A or B shall be used when the **surface** temperature of the hardened concrete is below 60 degrees F (16 degrees C).

 When the design strength in paragraph 501-3.1 is based on compressive strength, a strength of 3500 psi (24 130 kPa) shall be specified. Testing shall be in accordance with ASTM C 39.

MATERIAL ACCEPTANCE

5015.1 ACCEPTANCE SAMPLING AND TESTING. All acceptance sampling and testing, with the exception of coring for thickness determination, necessary to determine conformance with the requirements specified in this section will be performed by the Engineer. Concrete shall be accepted for strength and thickness on a lot basis.

A lot shall consist of:

- [] cubic yards ([] cubic meters).]
- [] square yards ([] square meters).]
- [a day's production not to exceed 2,000 cubic yards (1 530 cubic meters).]
- [a day's production not to exceed [] square yards ([] square meters).]

Testing organizations performing these tests shall meet the requirements of ASTM C 1077. The Contractor shall bear the cost of providing curing facilities for the strength specimens, per paragraph 501-5.1a(3), and coring and filling operations, per paragraph 501-5.1 b(1).

 The Engineer shall specify the lot size for a project based on the total quantity and the expected production rate. The lot size should not exceed 2,000 cubic yards (1 530 cubic meters). For projects where basis of payment is square yards (square meters), the Engineer shall convert the lot size to an equivalent area that contains 2,000 cubic yards (1530 cubic meters) or less.

a. Flexural Strength.

(1) **Sampling.** Each lot shall be divided into four equal sublots. One sample shall be taken for each subplot from the plastic concrete delivered to the job site. Sampling locations shall be determined by the Engineer in accordance with random sampling procedures contained in ASTM D 3665. The concrete shall be sampled in accordance with ASTM C 172.

(2) **Testing.** Two (2) specimens shall be made from each sample. Specimens shall be made in accordance with ASTM C 31 and the flexural strength of each specimen shall be determined in accordance with ASTM C 78. The flexural strength for each subplot shall be computed by averaging the results of the two test specimens representing that subplot.

(3) **Curing.** The Contractor shall provide adequate facilities for the initial curing of beams. During the 24 hours after molding, the temperature immediately adjacent to the specimens must be maintained in the range of 60 to 80 degrees F (16 to 27 degrees C), and loss of moisture from the specimens must be prevented. The specimens may be stored in tightly constructed wooden boxes, damp sand pits, temporary buildings at construction sites, under wet burlap in favorable weather, or in heavyweight closed plastic bags, or using other suitable methods, provided the temperature and moisture loss requirements are met.

(4) **Acceptance.** Acceptance of pavement for flexural strength will be determined by the Engineer in accordance with paragraph 501-5.2b.

 Preventing loss of moisture is extremely important since relatively small amounts of surface drying of flexural specimens can induce tensile stresses in the extreme fibers that will markedly reduce the indicated flexural strength.

501-5.2 ACCEPTANCE CRITERIA.

a. General. Acceptance will be based on the following characteristics of the completed pavement:

- | | |
|-----------------------|-------------------------|
| (1) Flexural strength | (4) Grade |
| (2) Thickness | (5) Edge slump |
| (3) Smoothness | (6) Dowel bar alignment |

Flexural strength and thickness shall be evaluated for acceptance on a lot basis using the method of estimating percentage of material within specification limits (**PWL**). Acceptance using **PWL** considers the variability (standard deviation) of the material and the testing procedures, as well as the average (mean) value of the test results to calculate the percentage of material that is above the lower specification tolerance limit (**L**).

Acceptance for **flexural** strength will be based on the criteria contained in accordance with paragraph 501-5.2e(1). Acceptance for thickness will be based on the criteria contained in paragraph 501-5.2e(2). Acceptance for smoothness will be based on the criteria contained in paragraph 501-5.2e(3). Acceptance for grade will be based on the criteria contained in paragraph 501-5.2e(4).

The Engineer may at any time, notwithstanding previous plant acceptance, reject and require the Contractor to dispose of any batch of concrete mixture which is rendered unfit for use due to contamination, segregation, or improper slump. Such rejection may be based on only visual inspection. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the Engineer, and if it can be demonstrated in the laboratory, in the presence of the Engineer, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

b. Flexural Strength. Acceptance of each lot of in-place pavement for **flexural** strength shall be based on **PWL**. The Contractor shall target production quality to achieve 90 **PWL** or higher.

 When the design strength in paragraph 501-3.1 is based on compressive strength, substitute compressive strength for **flexural** strength.

c. Pavement Thickness. Acceptance of each lot of in-place pavement shall be based on **PWL**. The Contractor shall target production quality to achieve 90 **PWL** or higher.

d. Percentage of Material Within Limits (PWL). The percentage of material within limits (**PWL**) shall be determined in accordance with procedures specified in Section 110 of the General Provisions.

The lower specification tolerance limit (**L**) for **flexural** strength and thickness shall be:

Lower Specification Tolerance Limit (L)

Flexural Strength	0.93 x strength specified in paragraph 501-3.1
Thickness	Lot Plan Thickness in inches - 0.50 inches

 The lower specification tolerance limits above are based on applying statistical analysis to FAA design assumptions, and there is no need to compensate for the above factor in the design process. When the design strength in paragraph 501-3.1 is based on compressive strength, substitute compressive strength for **flexural** strength and insert 4,140 psi as **L** for strength.

 When the design requires paving an area less than 666 square yards (566 square meters), the Engineer
 may request **modification to this requirement**

501-6.2 QUALITY CONTROL TESTING. The Contractor shall perform all **quality** control tests necessary to control the production and construction processes applicable to this specification and as set forth in the Quality Control Program. The testing program shall include, but not necessarily be limited to, tests for aggregate gradation, aggregate moisture content, slump, and air content.

A Quality Control Testing Plan shall be developed as part of the Quality Control Program.

a. Fine Aggregate.

(1) **Gradation.** A sieve analysis shall be made at least twice daily in accordance with ASTM C 136 **from** randomly sampled material taken **from** the discharge gate of storage bins or **from** the conveyor belt.

(2) **Moisture Content.** If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C 70 or ASTM C 566.

b. Coarse Aggregate.

(1) **Gradation.** A sieve analysis shall be made at least twice daily for each size of aggregate. Tests shall be made in accordance with ASTM C 136 **from** randomly sampled material taken **from** the discharge gate of storage bins or **from** the conveyor belt.

(2) **Moisture Content.** If an electric **moisture** meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C 566.

c. Slump. Four slump tests shall be performed for each lot of material produced in accordance with the lot size defined in Section **501-5.1**. One test shall be made for each **sublot**. Slump tests shall be **performed** in accordance with ASTM C 143 from material randomly sampled **from** material discharged **from** trucks at the paving site. Material samples shall be taken in accordance with ASTM C 172.

d. Air Content. Four air content tests shall be performed for each lot of material produced in accordance with the lot size defined in Section **501-5.1**. One test shall be made for each **sublot**. Air content tests shall be **performed** in accordance with ASTM C 23 1 for gravel and stone coarse aggregate and ASTM C 173 for slag or other porous coarse aggregate, **from** material randomly sampled **from** trucks at the plant site. Material samples shall be **taken in accordance** with ASTM C 172.

501-6.3 CONTROL CHARTS. The Contractor shall maintain linear control charts for fine and coarse aggregate gradation, slump, and air content.

Control charts shall be posted in a location satisfactory to the Engineer and shall be kept up to date at all times. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the Action and suspension Limits, or Specification limits, applicable to each test parameter, and the **Contractor's** test results. The Contractor shall use the control charts as part of a process control system for **identifying** potential problems and assignable causes before they occur. If the Contractor's projected data during production indicates a potential problem and the Contractor is not taking **satisfactory** corrective action, the Engineer may halt production or acceptance of the material.

a. Fine and Coarse Aggregate Gradation. The Contractor shall record the running average of the last five gradation tests for each control sieve on linear control charts. Specification limits contained in Tables 1 and 2 shall be superimposed on the Control Chart for job control.

b. Slump and Air Content. The Contractor shall maintain linear control charts both for individual measurements and range (i.e. difference between highest and lowest measurements) for slump and **air** content in accordance with the following Action and Suspension Limits.

The Engineer shall specify a value ranging from 100 percent to 106 percent. When the total project payment for Item P-501 pavement exceeds the contract unit price, any AIP or PFC funds used to pay the excess may require an amendment to the AIP grant or PFC application for the project.

a. Basis of Adjusted Payment. The pay factor for each individual lot shall be calculated in accordance with Table 3. A pay factor shall be calculated for both **flexural** strength and thickness. The lot pay factor shall be the higher of the two values when calculations for both **flexural strength** and thickness are 100 percent or higher. The lot pay factor shall be the product of the two values when only one of the calculations for either **flexural** strength or thickness is 100 percent or higher. The lot pay factor shall be the lower of the two values when calculations for both **flexural** strength and thickness are less than 100 percent .

TABLE 3. PRICE ADJUSTMENT SCHEDULE ¹

Percentage of Material Within Specification Limits (PWL)	Lot Pay Factor (Percent of Contract Unit Price)
96 – 100	106
90 – 95	PWL + 10
75-90	0.5PWL + 55
55 – 74	1.4PWL – 12
Below 55	Reject ²

¹ ALTHOUGH IT IS THEORETICALLY POSSIBLE TO ACHIEVE A PAY FACTOR OF 106 PERCENT FOR EACH LOT, ACTUAL PAYMENT IN EXCESS OF 100 PERCENT SHALL BE SUBJECT TO THE TOTAL PROJECT PAYMENT LIMITATION SPECIFIED IN PARAGRAPH 501-8.1.

² The lot shall be removed and replaced. However, the Engineer may decide to allow the rejected lot to remain. In that case, if the Engineer and Contractor agree in writing that the lot shall not be removed, it shall be paid for at 50 percent of the contract unit price AND THE TOTAL PROJECT PAYMENT LIMITATION SHALL BE REDUCED BY THE AMOUNT WITHHELD FOR THE REJECTED LOT.

For each lot accepted, the adjusted contract unit price shall be the product of the lot pay factor for the lot and the contract unit price. Payment shall be subject to the total project payment limitation specified in paragraph 501-8.1. Payment in excess of 100 percent for accepted lots of concrete pavement shall be used to offset payment for accepted lots of concrete pavement that achieve a lot pay factor less than 100 percent.

b. Payment. Payment shall be made under:

Item P-501-8. 1a Portland Cement Concrete Pavement--[per cubic yard (cubic meter)] [per square yard (square meter)]

501-8.2 PAYMENT FOR SAW-CUT GROOVING. Payment for saw-cut grooving shall be made at the contract unit price per square yard (square meter) for saw-cut grooving.

Delete paragraph 501-8.2 if saw-cut grooving is not included in the project.

ASTM A 616	Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 617	Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 704	Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement
ASTM A 714	Specification for High-Strength Low-Alloy Welded and Seamless Steel Pipe
ASTM C 33	Specification for Concrete Aggregates
ASTM C 94	Specification for Ready-Mixed Concrete
ASTM C 150	Specification for Portland Cement
ASTM C 171	Specification for Sheet Materials for Curing Concrete
ASTM C 260	Specification for Air-Entraining Admixtures for Concrete
ASTM C 309	Specification for Liquid Membrane-Forming Compounds
ASTM C 494	Specification for Chemical Admixtures for Concrete
ASTM C 595	Specification for Blended Hydraulic Cements
ASTM C 618	Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 881	Specification for Epoxy-Resin-Base Bonding System for Concrete
ASTM C 989	Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM D 1751	Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving And Structural Construction
AASHTO M 254	Specification for Coated Dowel Bars
ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting
TT-P-644 (Rev. D)	Federal Specification for Primer Coating, Alkyd, Corrosion-Inhibiting, Lead and Chromate Free, VOC-Compliant